CASCADING USE OF GEOTHERMAL ENERGY WITH MODERATE TEMPERATURE IN MILK PASTEURIZATION PLANT

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Abstract

The cascading use of geothermal energy is the direct use of geothermal water energy from a geothermal energy source by many beneficiaries as follows: primary beneficiaries of geothermal energy, using the geothermal fluid derived from the probe as a source of energy, secondary beneficiaries of geothermal energy, using waste geothermal water derived from primary users; other geothermal energy users, using waste geothermal water derived from secondary users, often conditioned by the imposed requirements of the environmental protection.

Key words: geothermalism,energy plant, cascading use, milk pasteurization

INTRODUCTION

From the design data we note that the production probe ensures for the geothermal water a temperature of 100°C, an artesian flow of 60 l/s (≈ 215m^2/h) at a pressure of 4 bar wellhead; note also that the probe is equipped with a pump depth, providing a pump flow of approximately 75 l/s.

The conditions resulting from the design data, according to Lindal diagram can be seen, that at this temperature (100°C), geothermal water can be used as energy source for many uses.

MATERIAL AND METHOD

Among the possible uses, we remember to study the scheme of cascading use shown in *Figure 1.,* scheme comprising:

• two primary users: - binary power plant,
 - milk pasteurization plant,

• two secondary users: - a complex of greenhouses,
 - a pool complex for balneology treatments.

Also, the scheme presents the water geothermal system compound of:

- production probe,
- gas tank removal,
- pumping station.

However, the scheme of cascading use of the geothermal water also contains:

- a buffer tank,
- reinjection probe.

The cascading use described above and graphically illustrated in Figure 1. Is the result of the research activity in the domain of cascading use of geothermal water with moderate temperature and does not claim to cover the possibilities in the field, representing a proposal which was considered to be representative.

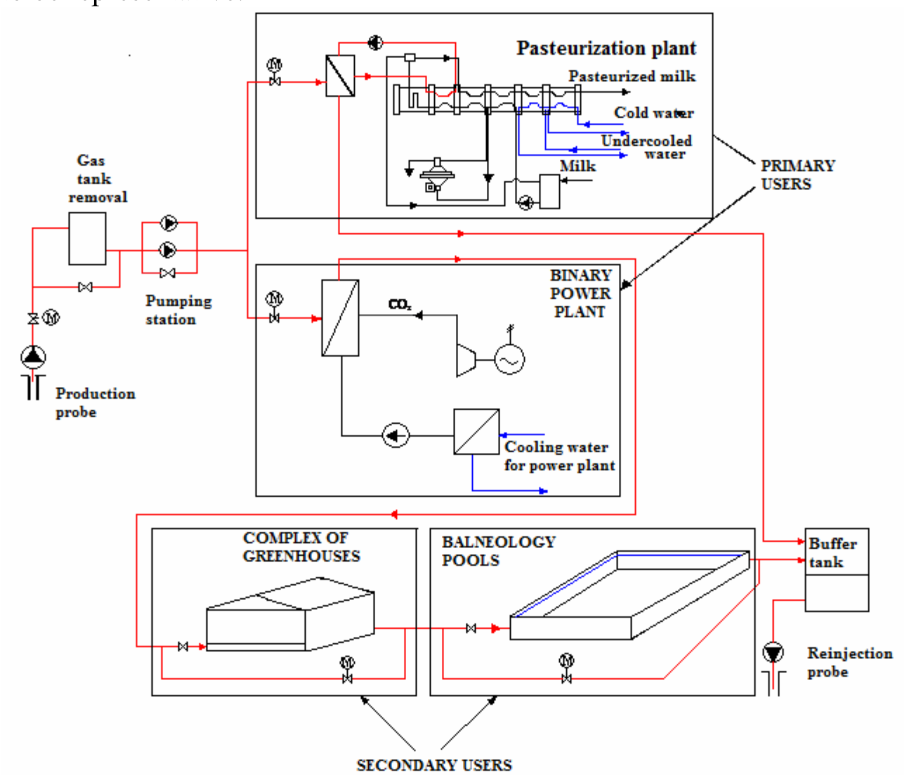

Fig .1 The cascading use

Next, there will be made a detailed analysis in terms of overall design and sizing calculations for the two user groups, namely *primary users* and *secondary users*.

As will be seen below, the sizing calculations for heating plant in providing milk pasteurization, and also for the complex of greenhouses and swimming pools for bathing cures were detailed.

RESULTS AND DISSCUSIONS

Pasteurization of milk shall ensure the destruction of almost all ordinary micro flora and the pathogen altogether. The pasteurization should consider the relationship time/temperature to ensure, on the one hand, the destruction of the Mycobacterium tuberculosis (curve 1) and, on the other hand, not to lead to changes in sensory and physicochemical properties of milk (curve 2). It follows that any particular pasteurization regime must fall between the two curves (right 3) of the Dahlberg diagram (Figure 2).

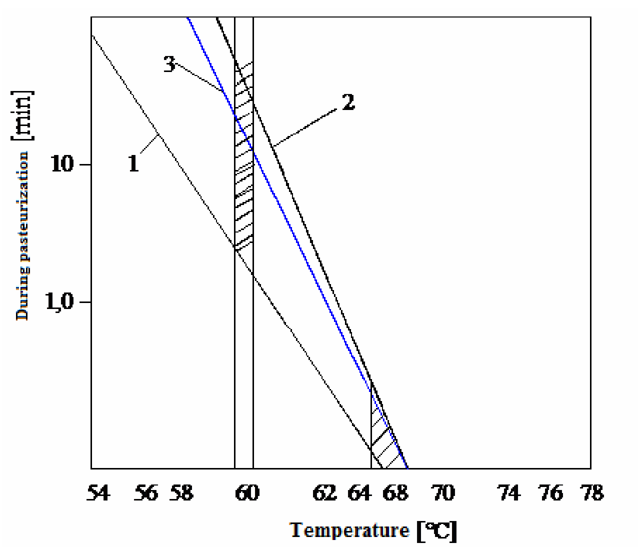

Fig. 2 The Dahlberg diagram

There can be used the following methods of pasteurization:

- *Slow* or *low pasteurization* at a temperature of 62-65°C/30 minutes, and 20 minutes.
- *Medium* or *short-term pasteurization*, which is performed at a temperature 72 ÷ 78°C/15 seconds, called HTST.
- *High* or *instant pasteurization* is carried out between 85-90°C for several seconds, followed by sudden cooling at 10°C.

Given the considerations outlined in section "general concept" it will be designed a milk pasteurization plant type TPL, which constructive design scheme is shown in Figure 3. and for which will be considered following design data:
- rated capacity, 40,000 l/h
- pasteurization temperature, 74-76°C
- cooling temperature, 6-8°C.

The plant (Figure 3) consists of the following appliances and equipment: tank float of 1000 l, 2 centrifugal pumps, maintenance area, pasteurization zone, 2 recovery zones, 2 cooling areas; SECEL centrifugal separator; by-pass flow valve; heat exchanger.

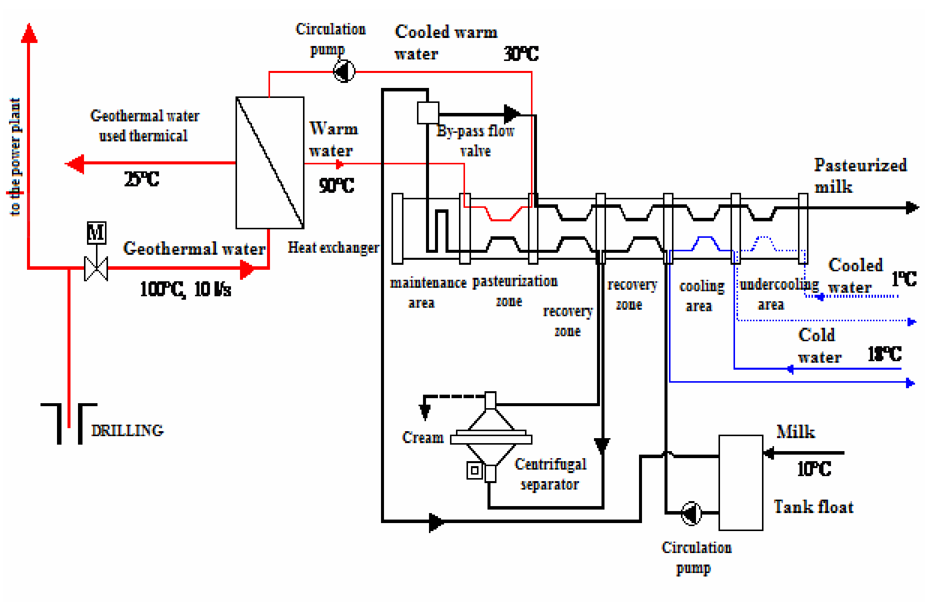

Fig. 3 The plant consists of the following appliances and equipment

The thermal regime is:

- preheating milk at a temperature of 35 ... 45°C in the first recovery area;
- preheating milk at a temperature of 53 ... 55°C in the second recovery area;
- heating milk at a temperature of 72 ... 76°C, using hot water with a temperature of 90 ... 95°C, in the pasteurization area;
- maintaining the pasteurization temperature in the maintenance area;
- cooling milk at a temperature of 6 ... 8°C in two cooling areas: one with tap water and a the other one with cooled water at a temperature of 1°C.

The technical characteristics of the milk pasteurization plants type TPL 400 are given in *Table 1.*

Table 1.

Characteristics	*TPL 400*
Nominal capacity, l/h	40.000
Pasteurization temperature, ºC	74-76

Cooling temperature, ºC	6-8
Steam pressure, bar	0,6-4
Steam consumption, kg/h	1600
Warm water consumption (90…95ºC), l/h	45.000
Cold water consumption (18ºC), l/h	120000
Cooled water consumption, l/h	120000
Air consumption (10 bar), m^3/h	192

The calculation of temperature outlet of the geothermal water can be determined by equating the heat flow given by the geothermal water with the heat flow received from the hot water:

$$Q_{geo} \cdot c \cdot (t_{geo\ in} - t_{geo\ out}) = Q_{water} \cdot c \cdot (t_{water\ out} - t_{water\ in})$$

where:

Q_{water} = 45.000 l/h = 12,5 l/s
Q_{geo} = 10 l/s
$t_{geo\ in}$ = 100°C
$t_{water\ in}$ = 30°C
$t_{water\ out}$ = 90°C
c = 4180 W/kgK

result:

$$t_{geo\ out} = t_{geo\ in} - \frac{Q_{water} \cdot \left(t_{water\ out} - t_{water\ in}\right)}{Q_{geo}} = 100 - \frac{12{,}5 \cdot (90 - 30)}{10} = 25°C$$

For the heat exchanger it is required to use the equipment from the firm "Tehnofrig SA Cluj-Napoca", a company that makes heat exchanger equipments in plates with heat transfer coefficients K=1 ... 7 kW/m^2K. Under these conditions, heat exchange surface required $S_{geo/water}$ is calculated as follows:

$$Q_{geo} \cdot c \cdot \left(t_{geo\ in} - t_{geo\ out}\right) = K \cdot S_{geo/water} \cdot \Delta t_{med}$$

where:

K=2.500 W/m^2K,

Δt_{med} - represents the mean temperature difference for the two fluids

$$\Delta t_{med} = \frac{\left(t_{geo\ in} - t_{water\ out}\right) - \left(t_{water\ in} - t_{geo\ out}\right)}{\ln \dfrac{t_{geo\ in} - t_{water\ out}}{t_{water\ in} - t_{geo\ out}}}$$

$$\Delta t_{med} = \frac{(100-90)-(30-25)}{\ln \dfrac{(100-90)}{(30-25)}} = 7{,}2^{o}\,C$$

result:

$$S_{geo/water} = \frac{Q_{geo} \cdot c \cdot \left(t_{geo\ in} - t_{geo\ out}\right)}{K \cdot \Delta t_{med}} = \frac{10 \cdot 4186 \cdot (100-25)}{2.500 \cdot 7{,}2} \cong 180\ m^2$$

The needed heat capacity of the heat exchanger is:

$$P_{need} = Q_{geo} \cdot c \cdot \left(t_{geo\ in} - t_{geo\ out}\right) = 10 \cdot 1.000 \cdot (100-25) = 750.000\ Kcal = 0{,}75\ Gcal$$

CONCLUSIONS

There are chosen from the product catalogue of the company "Tehnofrig SA Cluj-Napoca" 3 heat exchangers devices connected in series type SCPW0.55-70.4 with the following technical data:

- heat capacity 1,3 Gcal/h;
- primary heat flow 36 m^3/ h;
- temperature input / output primary heat 100/25°C;
- secondary heat flow 45 m^3/h;
- temperature input / output secondary heat 30/90°C;
- max. working temperature 150°C;
- maximum pressure drop in primary and secondary 0,2 bar;
- max. work pressure (primary and secondary) 10 bar;
- max. pressure difference between primary and secondary 10 bar;
- heat exchange area: 70 m^2;
- global heat exchange coefficient 2.5 kW/m^2K.

Geothermal water in milk pasteurization plant, having a temperature of about 25°C, according to Lindal diagram, this water can be still used in cascade for defrost, for the increase of juvenile fish growth or can be reinjected in the reservoir using a reinjection probe.

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